

CLAIMS

We Claim:

5

1. An Alq₃-functionalized compound comprising a polymerizable moiety and an Alq₃-moiety, wherein q, in each instance, comprises an 8-hydroxyquinoline residue.

10

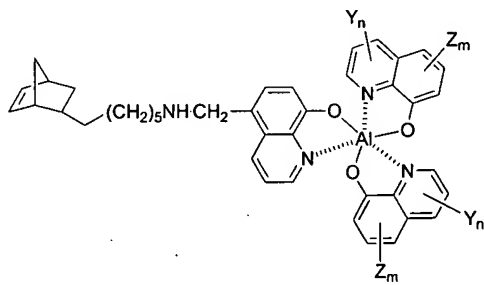
2. The Alq₃-functionalized compound of Claim 1, wherein the Alq₃-moiety is functionalized with at least one electron-donating group, at least one electron-withdrawing group, or a combination thereof.

15

3. The Alq₃-functionalized compound of Claim 1, wherein the Alq₃-moiety is functionalized with at least one group independently selected from: a hydrocarbaryl group, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, an inorganic group, an organometallic group, or a substituted analog thereof, any one of which having from 1 to about 30 carbon atoms; a halide; hydrogen; or any combination thereof.

20

4. The Alq₃-functionalized compound of Claim 1, wherein the compound has



the formula

wherein Y and Z are independently selected from -F, -Cl, -Br, -I, -R¹, -
 25 CR¹=O, -CH=CHC(O)R¹, -C(O)R¹, -C(O)OR¹, -CN, -C(NR¹)R¹, -C(NR¹)OR¹, -

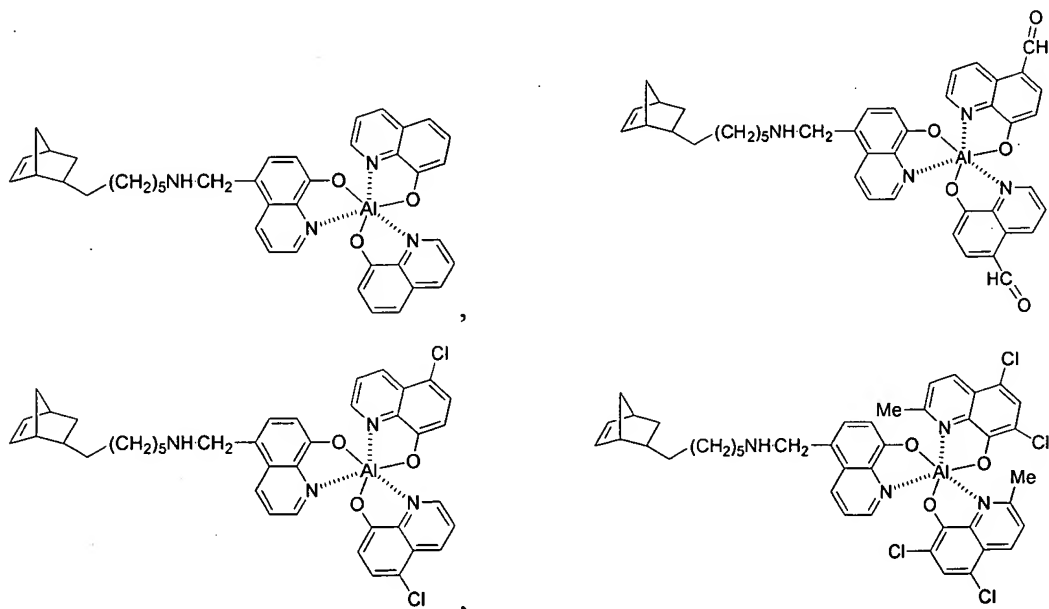
$\text{CH}_2\text{C}_6\text{H}_4\text{X}$, $-\text{CH}_2\text{C}_6\text{H}_3\text{X}_2$, $-\text{CH}_2\text{C}_6\text{H}_4\text{R}^1$, $-\text{CH}_2\text{C}_6\text{H}_3\text{R}^1_2$, $-\text{CH}_2\text{CH}_2\text{C}_6\text{H}_4\text{X}$, $-\text{CH}_2\text{CH}_2\text{C}_6\text{H}_3\text{X}_2$, $\text{CH}_2\text{CH}_2\text{C}_6\text{H}_4\text{R}^1$, $-\text{CH}_2\text{CH}_2\text{C}_6\text{H}_3\text{R}^1_2$, $-\text{CH}=\text{CR}^1_2$, $-\text{C}\equiv\text{CR}^1$, $-\text{OR}^1$, $-\text{OC}(\text{O})\text{R}^1$, $-\text{SiR}^1_3$, $-\text{OSiR}^1_3$, $-\text{NO}_2$, $-\text{NR}^1_2$, $-\text{N}_3$, $-\text{N}=\text{CR}^1_2$, $-\text{N}=\text{NR}^1$, $-\text{SR}^1$, $-\text{SX}$, $-\text{OSO}_2\text{R}^1$, $-\text{OSO}_2\text{OR}^1$, $-\text{SCN}$, $-\text{SO}_2\text{R}^1$, $-\text{PR}^1_2$, $-\text{PX}_2$, $-\text{P}(\text{O})\text{R}^1_2$, $-\text{P}(\text{OR}^1)_2$, $-\text{P}(\text{O})(\text{OR}^1)_2$, $-\text{OSiR}^1_3$, $-\text{OPR}^1_2$, $-\text{OAlR}^1_2$, $-\text{AsR}^1_2$, $-\text{As}(\text{O})\text{R}^1_2$, $-\text{As}(\text{OR}^1)_2$, $-\text{As}(\text{O})(\text{OR}^1)_2$, SnR^1_3 , OSnR^1_3 , SnX^1_3 , OSnX^1_3 , $-\text{BR}^1_2$, $-\text{BX}_2$, $-\text{BR}^1\text{X}$, $-\text{SO}_2\text{X}$, $-\text{OAlX}_2$, $-\text{OSiX}_3$, $-\text{OPX}_2$, $-\text{OSO}_2\text{X}$, $-\text{AsX}_2$, or $-\text{As}(\text{O})\text{X}_2$;

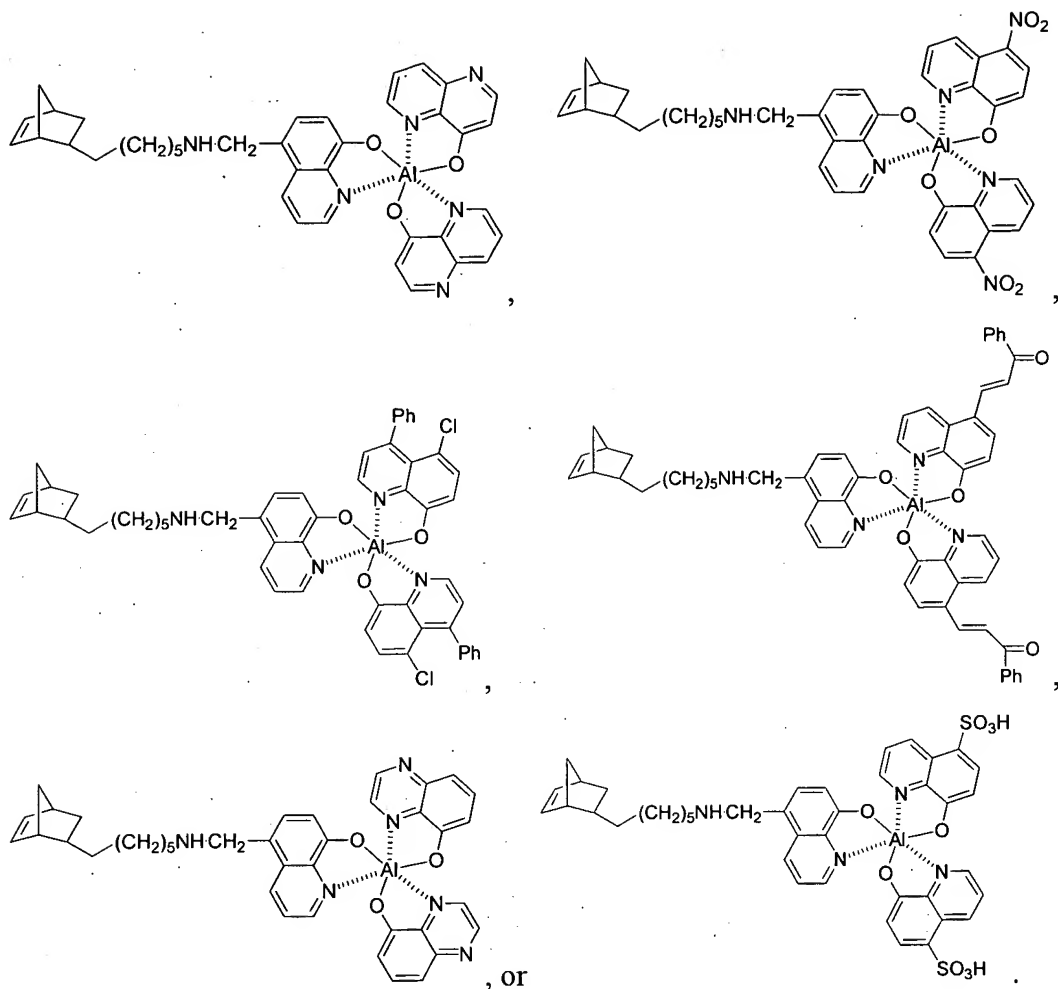
wherein R^1 , in each instance, is independently selected from H or a substituted or unsubstituted hydrocarbyl group having from 1 to about 30 carbon atoms;

wherein X, in each instance, is independently selected from F, Cl, Br, I, H, OR^1 , $-\text{SR}^1$, or NR^1_2 ; and

wherein n and m are independently selected from an integer from 0 to 3.

5. The Alq_3 -functionalized compound of Claim 1, wherein the compound is selected from:





5 6. A light-emitting diode comprising the polymerization product of the Alq₃-functionalized compound of Claim 1.

7. A composition comprising the polymerization product of an Alq₃-functionalized monomer, wherein the Alq₃-functionalized monomer comprises a
10 polymerizable moiety and an Alq₃-moiety, and wherein q, in each instance, comprises an 8-hydroxyquinoline residue.

8. The composition of Claim 7, wherein the polymerization product is substantially non-crosslinked.

9. The composition of Claim 7, wherein the Alq₃-moiety is functionalized with at least one electron-donating group, at least one electron-withdrawing group, or a combination thereof.
- 5 10. The composition of Claim 7, wherein the polymerizable moiety comprises norbornene.
11. A light-emitting diode comprising the composition of Claim 7.
- 10 12. A composition comprising the polymerization product of at least one Alq₃-functionalized monomer and at least one comonomer, wherein the Alq₃-functionalized monomer comprises a polymerizable moiety and an Alq₃-moiety, and wherein q, in each instance, comprises an 8-hydroxyquinoline residue.
- 15 13. The composition of Claim 12, wherein the polymerizable moiety comprises norbornene, norbornadiene, cyclopentene, cyclooctene, cyclooctadiene, or a substituted analog thereof.
14. The composition of Claim 12, wherein the polymerizable moiety
20 comprises norbornene or a substituted analog thereof.
15. The composition of Claim 12, wherein the Alq₃-moiety is functionalized with at least one electron-donating group, at least one electron-withdrawing group, or a combination thereof.
- 25 16. The composition of Claim 12, wherein the Alq₃-moiety is functionalized with at least one group independently selected from: a hydrocarbyl group, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead
30 group, a boron group, an aluminum group, an inorganic group, an organometallic

group, or a substituted analog thereof, any one of which having from 1 to about 30 carbon atoms; a halide; hydrogen; or any combination thereof.

17. The composition of Claim 12, wherein the Alq₃-moiety is functionalized with at least one group independently selected from -F, -Cl, -Br, -I, -R¹, -CR¹=O, -CH=CHC(O)R¹, -C(O)R¹, -C(O)OR¹, -CN, -C(NR¹)R¹, -C(NR¹)OR¹, -CH₂C₆H₄X, -CH₂C₆H₃X₂, -CH₂C₆H₄R¹, -CH₂C₆H₃R¹₂, -CH₂CH₂C₆H₄X, -CH₂CH₂C₆H₃X₂, CH₂CH₂C₆H₄R¹, -CH₂CH₂C₆H₃R¹₂, -CH=CR¹₂, -C≡CR¹, -OR¹, -OC(O)R¹, -SiR¹₃, -OSiR¹₃, -NO₂, -NR¹₂, -N₃, -N=CR¹₂, -N=NR¹, -SR¹, -SX, -OSO₂R¹, -OSO₂OR¹, -SCN, -SO₂R¹, -PR¹₂, -PX₂, -P(O)R¹₂, -P(OR¹)₂, -P(O)(OR¹)₂, -OSiR¹₃, -OPR¹₂, -OAlR¹₂, -AsR¹₂, -As(O)R¹₂, -As(OR¹)₂, -As(O)(OR¹)₂, SnR¹₃, OSnR¹₃, SnX¹₃, OSnX¹₃, -BR¹₂, -BX₂, -BR¹X, -SO₂X, -OAlX₂, -OSiX₃, -OPX₂, -OSO₂X, -AsX₂, or -As(O)X₂; wherein R¹, in each instance, is independently selected from H or a substituted or unsubstituted hydrocarbyl group having from 1 to about 30 carbon atoms; and wherein X, in each instance, is independently selected from F, Cl, Br, I, H, OR¹, -SR¹, or NR¹₂.

18. The composition of Claim 12, wherein the Alq₃-moiety is functionalized by at least one group independently selected from alkyl, cycloalkyl, alkenyl, alkynyl, aryl, aralkyl, formyl, acyl, imide, amide, imine, alkoxide, aryloxide, alkylthiolate, arylthiolate, alkoxyalkyl, haloalkyl, carboxylate, or a substituted analog thereof, any one of which having up to about 30 carbon atoms.

19. The composition of Claim 12, wherein the Alq₃-moiety is functionalized by at least one group independently selected from methyl, ethyl, propyl, cyclopropyl, n-butyl, tert-butyl, sec-butyl, isobutyl, cyclobutyl, amyl, isoamyl, pentyl, cyclopentyl, hexyl, cyclohexyl, cycloheptyl, heptyl, octyl, cyclooctyl, nonyl, decyl, dodecyl, 2-ethylhexyl, pentenyl, butenyl, benzyl, phenyl, tolyl, naphthyl, anthracenyl, F, Cl, Br, I, OMe, OEt, O-n-Pr, O-i-Pr, O-n-Bu, O-t-Bu, O-s-Bu, OPh, OC₆H₄Me, OC₆H₃Me₂, NMe₂, NEt₂, NPh₂, NHMe, NHEt, NHPh, -

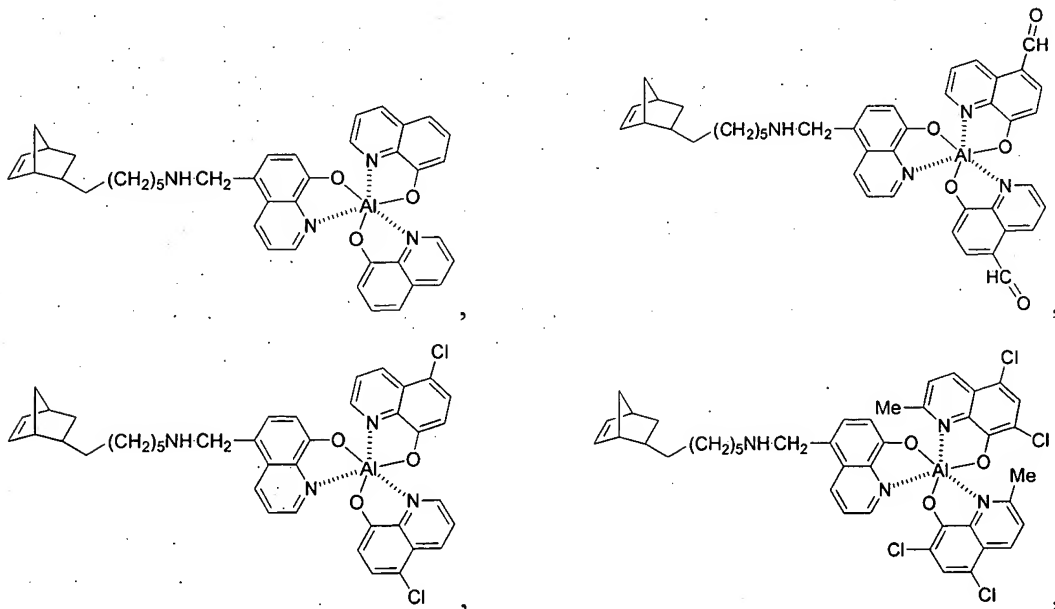
CH=O, -CH=CHC(O)Ph, or a substituted analog thereof, any one of which having up to about 30 carbon atoms.

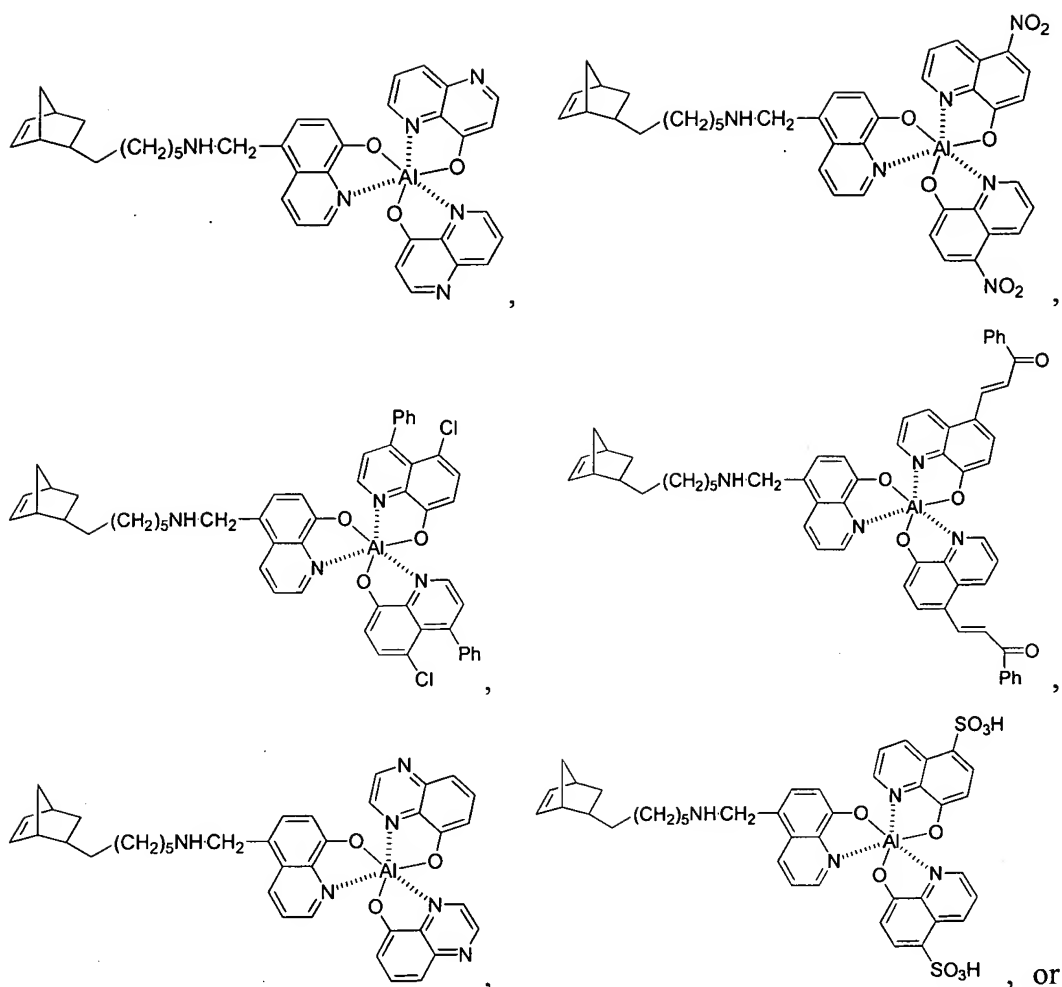
20. The composition of Claim 12, wherein the Alq₃-functionalized monomer further comprises a chemical spacer between the polymerizable moiety and the Alq₃-moiety, having between 1 and about 30 carbon atoms.

21. The composition of Claim 20, wherein the chemical spacer is selected from -(CH₂)_nNHCH₂- or -(CH₂)_nNR¹CH₂-, wherein n is from 1 to about 12, and R¹ is selected from a hydrocarbyl or substituted hydrocarbyl having from 1 to about 30 carbon atoms.

22. The composition of Claim 12, wherein the polymerization product comprises a block copolymer or a random copolymer.

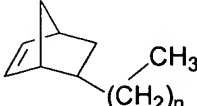
23. The composition of Claim 12, wherein the Alq₃-functionalized monomer is selected from:





5

24. The composition of Claim 12, wherein the at least one comonomer

comprises a compound with the formula , wherein n is an integer from 1 to about 12.

10 25. The composition of Claim 12, wherein the polymerization product is characterized by a polydispersity (M_w/M_n) from about 1.5 to about 1.8.

26. A light-emitting diode comprising the composition of Claim 12.

27. A method of making an Alq₃-functionalized polymer, comprising:
polymerizing an Alq₃-functionalized monomer in the presence or absence
of at least one comonomer;

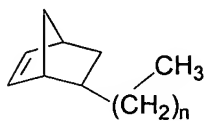
5 wherein the Alq₃-functionalized monomer comprises a polymerizable
moiety and an Alq₃-moiety; and

wherein q, in each instance, comprises an 8-hydroxyquinoline residue.

28. The method of Claim 27, wherein the Alq₃-functionalized monomer is
10 polymerized in the presence of at least one comonomer.

29. The method of Claim 27, wherein the Alq₃-functionalized monomer is
polymerized in the presence of at least one comonomer, and wherein the molar
ratio of Alq₃-functionalized monomer to comonomer is from about 1:1 to about
15 1:100.

30. The method of Claim 27, wherein the Alq₃-functionalized monomer is
polymerized in the presence of at least one comonomer comprising



20 (CH₂)_n, wherein n is an integer from 1 to about 12.

31. The method of Claim 27, wherein the polymerizable moiety of the Alq₃-
functionalized monomer is selected from norbornene, norbornadiene,
cyclopentene, cyclooctene, cyclooctadiene, or a functionalized analog thereof.

25 32. The method of Claim 27, wherein the method comprises a ring-opening
metathesis polymerization (ROMP) method.

33. The method of Claim 27, wherein the method comprises a radical polymerization method or a living radical polymerization method.
34. The method of Claim 27, wherein the polymerization is conducted in the presence of a catalyst comprising a transition metal carbene compound.
35. The method of Claim 27, wherein the polymerization is conducted in the presence of a catalyst comprising $\text{Ru}(\text{CHPh})\text{Cl}_2[\text{CHN}_2(\text{mesityl})_2\text{C}_2\text{H}_4](\text{PCy}_3)$.
36. The method of Claim 27, wherein the Alq_3 -moiety is functionalized with at least one group independently selected from: a hydrocarbyl group, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, an inorganic group, an organometallic group, or a substituted analog thereof, any one of which having from 1 to about 30 carbon atoms; a halide; hydrogen; or any combination thereof.
37. The method of Claim 27, wherein the Alq_3 -moiety is functionalized with at least one group independently selected from -F, -Cl, -Br, -I, -R¹, -CR¹=O, -CH=CHC(O)R¹, -C(O)R¹, -C(O)OR¹, -CN, -C(NR¹)R¹, -C(NR¹)OR¹, -CH₂C₆H₄X, -CH₂C₆H₃X₂, -CH₂C₆H₄R¹, -CH₂C₆H₃R¹₂, -CH₂CH₂C₆H₄X, -CH₂CH₂C₆H₃X₂, -CH₂CH₂C₆H₄R¹, -CH₂CH₂C₆H₃R¹₂, -CH=CR¹₂, -C≡CR¹, -OR¹, -OC(O)R¹, -SiR¹₃, -OSiR¹₃, -NO₂, -NR¹₂, -N₃, -N=CR¹₂, -N=NR¹, -SR¹, -SX, -OSO₂R¹, -OSO₂OR¹, -SCN, -SO₂R¹, -PR¹₂, -PX₂, -P(O)R¹₂, -P(OR¹)₂, -P(O)(OR¹)₂, -OSiR¹₃, -OPR¹₂, -OAlR¹₂, -AsR¹₂, -As(O)R¹₂, -As(OR¹)₂, -As(O)(OR¹)₂, SnR¹₃, OSnR¹₃, SnX¹₃, OSnX¹₃, -BR¹₂, -BX₂, -BR¹X, -SO₂X, -OAlX₂, -OSiX₃, -OPX₂, -OSO₂X, -AsX₂, or -As(O)X₂; wherein R¹, in each instance, is independently selected from H or a substituted or unsubstituted hydrocarbyl group having from 1 to about 30 carbon atoms; and wherein X, in each instance, is independently selected from F, Cl, Br, I, H, OR¹, -SR¹, or NR¹₂.

38. The method of Claim 27, wherein the Alq₃-moiety is functionalized by at least one group independently selected from alkyl, cycloalkyl, alkenyl, alkynyl, aryl, aralkyl, formyl, acyl, imide, amide, imine, alkoxide, aryloxy, alkylthiolate, arylthiolate, alkoxyalkyl, haloalkyl, carboxylate, or a substituted analog thereof, any one of which having up to about 30 carbon atoms.

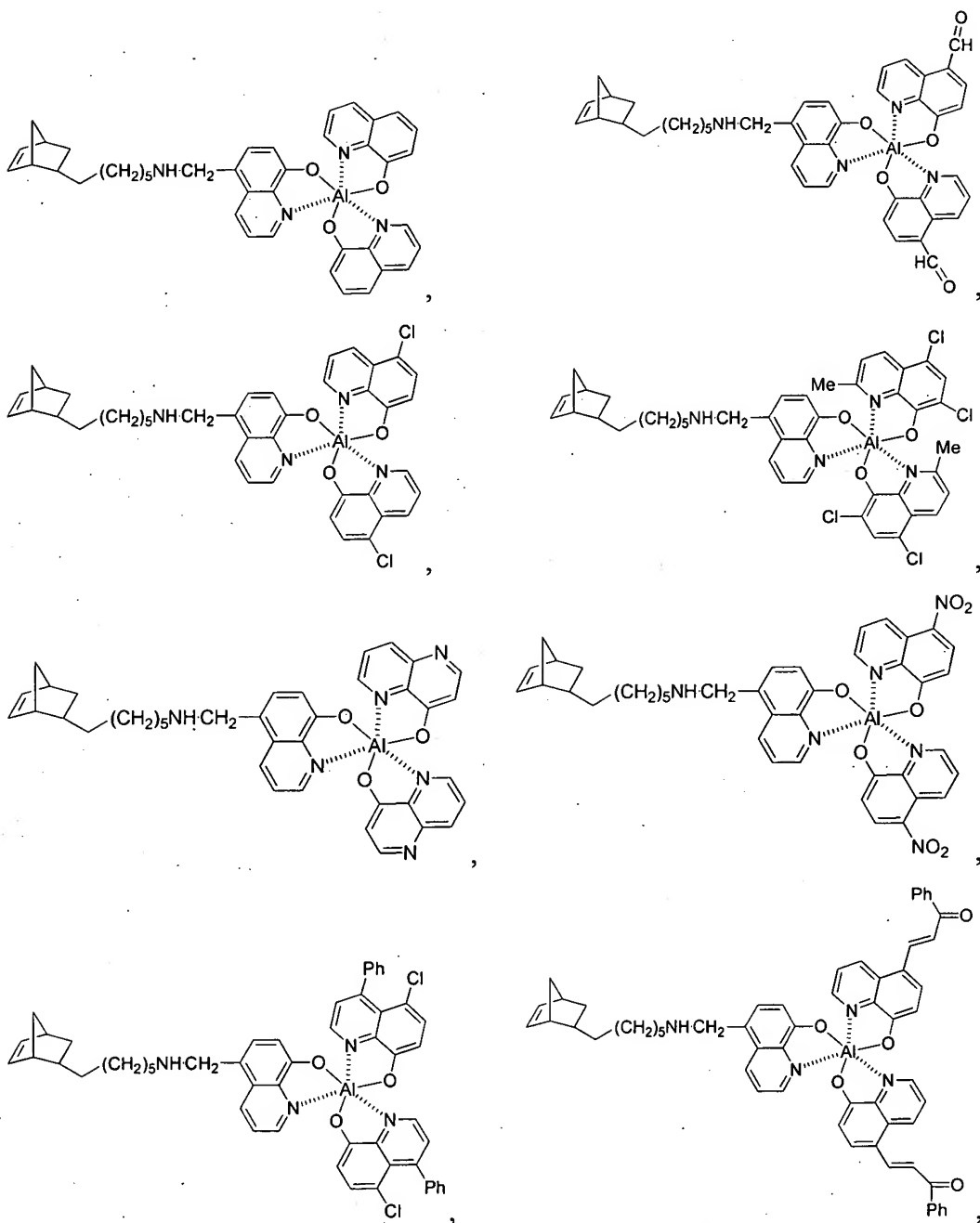
39. The method of Claim 27, wherein the Alq₃-moiety is functionalized by at least one group independently selected from methyl, ethyl, propyl, cyclopropyl, n-butyl, tert-butyl, sec-butyl, isobutyl, cyclobutyl, amyl, isoamyl, pentyl, cyclopentyl, hexyl, cyclohexyl, cycloheptyl, heptyl, octyl, cyclooctyl, nonyl, decyl, dodecyl, 2-ethylhexyl, pentenyl, butenyl, benzyl, phenyl, tolyl, naphthyl, anthracenyl, F, Cl, Br, I, OMe, OEt, O-n-Pr, O-i-Pr, O-n-Bu, O-t-Bu, O-s-Bu, OPh, OC₆H₄Me, OC₆H₃Me₂, NMe₂, NEt₂, NPh₂, NHMe, NHEt, NHPh, -CH=O, -CH=CHC(O)Ph, or a substituted analog thereof, any one of which having up to about 30 carbon atoms.

40. The method of Claim 27, wherein the Alq₃-functionalized monomer further comprises a chemical spacer between the polymerizable moiety and the Alq₃-moiety, having between 1 and about 30 carbon atoms.

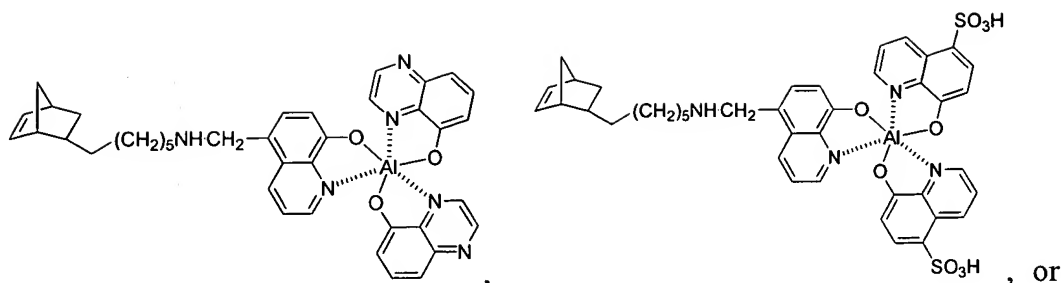
41. The method of Claim 40, wherein the chemical spacer is selected from -(CH₂)_nNHCH₂- or -(CH₂)_nNR¹CH₂-, wherein n is from 1 to about 12, and R¹ is selected from a hydrocarbyl or substituted hydrocarbyl having from 1 to about 30 carbon atoms.

42. The method of Claim 27, wherein the polymerization product comprises a block copolymer.

43. The method of Claim 27, wherein the Alq₃-functionalized monomer is selected from:

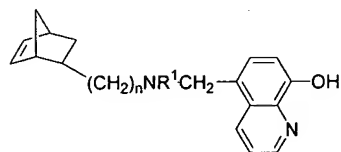


5



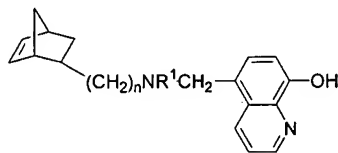
any combination thereof.

44. A method of functionalizing a polymer with an Alq₃ moiety, comprising:
 5 providing an Alq₃-functionalized monomer; and
 polymerizing an Alq₃-functionalized monomer in the presence or absence
 of at least one comonomer;
 wherein the Alq₃-functionalized monomer comprises a polymerizable
 moiety and an Alq₃-moiety; and
 10 wherein q, in each instance, comprises an 8-hydroxyquinoline residue.



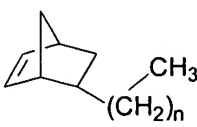
45. A compound having the formula
 from 1 to about 12; and R¹ is selected from H, a hydrocarbyl, or a substituted
 hydrocarbyl having from 1 to about 30 carbon atoms.

46. A composition comprising the polymerization product of:



- 1) a compound having the formula
 is from 1 to about 12; and R¹ is selected from H, a hydrocarbyl, or a substituted
 hydrocarbyl having from 1 to about 30 carbon atoms; and
 2) at least one optional comonomer having up to about 30 carbon atoms.

47. The composition of Claim 46, wherein the at least one comonomer

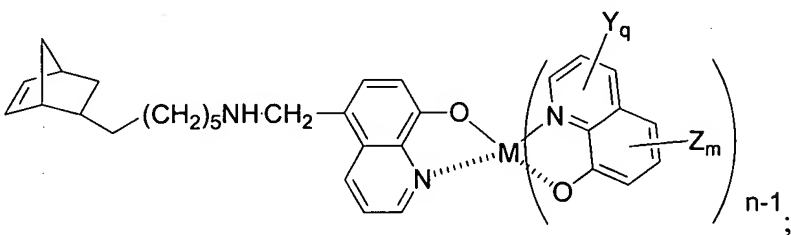
comprises a compound with the formula , wherein n is an integer from 1 to about 12.

5 48. An Mq_n -functionalized compound comprising a polymerizable moiety and an Mq_n -moiety, wherein q, in each instance, comprises an 8-hydroxyquinoline residue, and M is selected from Mg, Zn, Al, Ga, or In; and n is selected from 2 or 3 according to the valence of the metal.

10 49. The Mq_n -functionalized compound of Claim 48, wherein the Mq_n -moiety is functionalized with at least one electron-donating group, at least one electron-withdrawing group, or a combination thereof.

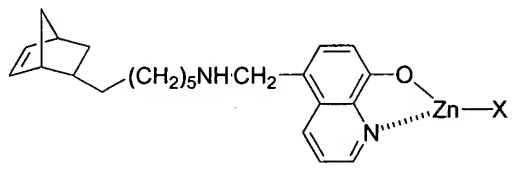
50. The Mq_n -functionalized compound of Claim 48, wherein the Mq_n -moiety is functionalized with at least one group independently selected from: a hydrocarbyl group, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, an inorganic group, an organometallic group, or a substituted analog thereof, any one of which
15
20 having from 1 to about 30 carbon atoms; a halide; hydrogen; or any combination thereof.

51. The Mq_n -functionalized compound of Claim 48, wherein the compound

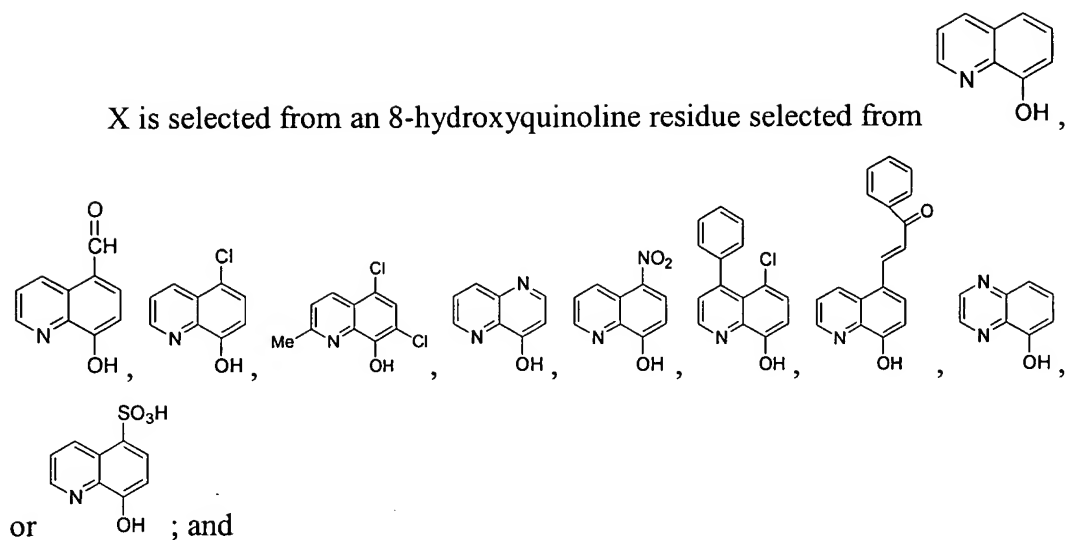
has the formula 

- wherein Y and Z are independently selected from -F, -Cl, -Br, -I, -R¹, -CR¹=O, -CH=CHC(O)R¹, -C(O)R¹, -C(O)OR¹, -CN, -C(NR¹)R¹, -C(NR¹)OR¹, -CH₂C₆H₄X, -CH₂C₆H₃X₂, -CH₂C₆H₄R¹, -CH₂C₆H₃R¹₂, -CH₂CH₂C₆H₄X, -CH₂CH₂C₆H₃X₂, CH₂CH₂C₆H₄R¹, -CH₂CH₂C₆H₃R¹₂, -CH=CR¹₂, -C≡CR¹, -OR¹, -OC(O)R¹, -SiR¹₃, -OSiR¹₃, -NO₂, -NR¹₂, -N₃, -N=CR¹₂, -N=NR¹, -SR¹, -SX, -OSO₂R¹, -OSO₂OR¹, -SCN, -SO₂R¹, -PR¹₂, -PX₂, -P(O)R¹₂, -P(OR¹)₂, -P(O)(OR¹)₂, -OSiR¹₃, -OPR¹₂, -OAlR¹₂, -AsR¹₂, -As(O)R¹₂, -As(OR¹)₂, -As(O)(OR¹)₂, SnR¹₃, OSnR¹₃, SnX¹₃, OSnX¹₃, -BR¹₂, -BX₂, -BR¹X, -SO₂X, -OAlX₂, -OSiX₃, -OPX₂, -OSO₂X, -AsX₂, or -As(O)X₂;
- wherein R¹, in each instance, is independently selected from H or a substituted or unsubstituted hydrocarbyl group having from 1 to about 30 carbon atoms;
- wherein X, in each instance, is independently selected from F, Cl, Br, I, H, OR¹, -SR¹, or NR¹₂; and
- wherein q and m are independently selected from an integer from 0 to 3.

52. The Mq_n-functionalized compound of Claim 48, wherein:



the compound has the formula



wherein the 8-hydroxyquinoline residue has been deprotonated.

5

53. A method of making a Mq_n -functionalized polymer, comprising:
- preparing a q_n -functionalized monomer;
 - polymerizing the monomer in the presence or absence of a comonomer to form a q_n -functionalized polymer; and
 - 10 reacting the polymer with a metal complex to form a Mq_n -functionalized polymer;

wherein M is selected from Mg, Zn, Al, Ga, or In; and n is selected from 2 or 3 according to the valence of the metal.

15